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Ontario Geological Survey
Open File Report 6189

Acquisition, Inversion and Presentation of Geophysical Data for Geoscientific Profiles in the Timmins–Kirkland Lake Area: Discover Abitibi Initiative

2006

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ONTARIO GEOLOGICAL SURVEY

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Acquisition, Inversion and Presentation of Geophysical Data for Geoscientific Profiles in the Timmins–Kirkland Lake Area: Discover Abitibi Initiative

by

E.L. Mueller, S.W. Reford, D.J.W. Dawson, D.F. Morrison, C. Pawluk, J. Grant, A. Spector, D.S. Rogers and T. Savage

2006

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Discover Abitibi
A project of innovation, cooperation and revitalization

Découvrons l' Abitibi
Un projet d' innovation, de coopération et de renouvellement

Discover Abitibi Initiative
The Discover Abitibi Initiative is a regional, cluster economic development project based on geoscientific investigations of the western Abitibi greenstone belt. The initiative, centred on the Kirkland Lake and Timmins mining camps, will complete 19 projects developed and directed by the local stakeholders. FedNor, Northern Ontario Heritage Fund Corporation, municipalities and private sector investors have provided the funding for the initiative.

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L'initiative Découvrons l'Abitibi est un project de développment économique régional dans une grappe d'industries, projet fondé sur des études géoscientifiques de la ceinture de roches vertes de l'Abitibi occidental. Cette initiative, centrée sur les zones minières de Kirkland Lake et de Timmins, ménera à bien 19 projets élaborés et dirigés par des intervenants locaux. FedNor, la Société de gestion du Fonds du patrimoine du Nord de l'Ontario, municipalités et des investisseurs du secteur privé ont fourni les fonds de cette initiative.

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KIRKLAND LAKE

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Geophysical Data Acquired for Geoscientific Profiles in the Timmins–Kirkland Lake Area: Discover Abitibi Initiative

by D.J.W. Dawson, D.F. Morrison, C. Pawluk, J. Grant, A. Spector, E.L. Mueller and S.W. Reford

This release contains the measured and processed geophysical data acquired for the geoscientific profiles described in Open File Report (OFR) 6189. Ground geophysical data for 3 parallel profiles, most of which are 2 km in length and spaced 200 m apart, were acquired at 15 different sites chosen for their proximity to known mineral deposits of various types. The data acquired include magnetic, gravity and pole–dipole induced polarization. In addition, an Insight Section was acquired on 1 profile at each site, usually the central profile, using a modified gradient induced polarization array. All standard reductions and corrections were applied to the data. The chargeability and resistivity data from both the Insight Sections and pole–dipole surveys were inverted using the University of British Columbia Geophysical Inversion Facility (UBC–GIF) DCIP2D inversion program. In addition, 5 regional maps, available in portable document format (*.pdf*), show the regional setting of the geoscientific profiles under the following themes: bedrock geology, residual magnetic field, Bouguer gravity field, electromagnetic field apparent conductance/conductivity and digital elevation model. A digital version of OFR 6189, including the 15 back-pocket charts, is also available in portable document format (*.pdf*). The measured and processed data are available in ASCII and Geosoft® formats on 1 CD-ROM.

This CD is available separately from this report.

Abstract

This report describes the acquisition, inversion and presentation of geophysical data acquired for geoscientific profiles in the Timmins–Kirkland Lake area, funded by the Discover Abitibi Initiative. The goals of the project were 1) to provide a concise visualization of several deposit types in the region; 2) to provide exploration personnel with a ready source for comparisons of geophysical data types related to known deposits, allowing explorationists to evaluate their anomalies against these deposit types; and 3) to disseminate the data sets and other products to clients in digital and hard-copy formats.

Ground geophysical data for 3 parallel profiles, most 2 km in length and spaced 200 m apart, were acquired at 15 different sites chosen for their proximity to known mineral deposits of various types. The data acquired include magnetic, gravity and pole–dipole induced polarization. In addition, an Insight Section was acquired on one profile at each site, usually the central profile, using a modified gradient induced polarization array. All standard reductions and corrections were applied to the data. The chargeability and resistivity data from both the Insight Sections and pole–dipole surveys were inverted using the University of British Columbia Geophysical Inversion Facility DCIP2D inversion program.

A back-pocket chart was prepared for each site for the survey line where the Insight Section was acquired. The processed field data from each method is presented in profile form (magnetic, gravity) or section form (Insight Section, pole–dipole induced polarization). In addition, the inversion results from the Insight chargeability and apparent resistivity are presented. For each site, a geological section was prepared for comparison with the geophysical, using data provided by the property holders. The geophysical anomalies were evaluated with respect to the known geology. Guidelines for ground geophysical exploration in the Abitibi region are provided.

Acquisition, Inversion and Presentation of Geophysical Data for Geoscientific Profiles in the Timmins–Kirkland Lake Area: Discover Abitibi Initiative

E.L. Mueller[1], S.W. Reford[2], D.J.W. Dawson[3], D.F. Morrison[4], C. Pawluk[5], J. Grant[6], A. Spector[7], D.S. Rogers[8] and T. Savage[9]

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[1]Senior Geophysicist, Paterson, Grant & Watson Ltd.,
85 Richmond St. W., 8th Floor, Toronto, Ontario M5H 2C9; edna.mueller@pgw.on.ca
[2]Vice President, Paterson, Grant & Watson Ltd.,
85 Richmond St. W., 8th Floor, Toronto, Ontario M5H 2C9; stephen.reford@pgw.on.ca
[3]Senior Geophysicist, Insight Geophysics; djwdawson@insightgeophysics.com
[4]President, Insight Geophysics; dmorrison@encode.com
[5]Vice President, Insight Geophysics; cpawluk@cogeco.ca
[6]President, Exsics Geophysics; jgrant@rogers.com
[7]President, Allan Spector and Associates; aspector@rogers.com
[8]Dean S. Rogers, *P.Geo.*; dsrogers@personainternet.com
[9]President, Tom Savage Drafting; sdg@vianet.ca

Introduction

This report describes the acquisition, processing, inversion and presentation of geophysical data for the geoscientific profiles in the Timmins–Kirkland Lake area project funded under the Discover Abitibi Initiative. The Discover Abitibi Initiative was designed to "coordinate and direct an integrated geoscientific investigation of the Abitibi greenstone belt of northeastern Ontario" (www.DiscoverAbitibi.com). The Discover Abitibi Initiative aimed to stimulate the minerals industry by funding geophysical and geological projects to generate new exploration targets. This mission of the Discover Abitibi Initiative was accomplished by an integrated series of projects ranging from airborne geophysical surveys, investigation of metallogenic architecture, three-dimensional (3D) mineral deposit modelling and the geoscientific profiles project presented here.

The geoscientific profiles project has 3 goals:

1. provide a concise visualization of several deposit types in the region;
2. provide exploration personnel with a ready source for comparisons of geophysical data types related to known deposits, allowing explorationists to evaluate their anomalies against these deposit types;
3. to disseminate the data sets and other products to clients in digital and hard-copy formats.

This report concerns the geophysical data acquired at 15 sites. Geochemical surveys will be undertaken at some of these sites, and will be published separately (Fedikow 2006a, 2006b).

Overview of the Project

The ground geophysical surveys over 15 known deposits in the Timmins, Matheson and Kirkland Lake areas were carried out to characterize the geological responses to the geophysical methods employed. The site locations (Figure 1) were determined by a technical committee employed by the Discover Abitibi Initiative.

PROJECT TEAM

The project was carried out under contract by Insight Geophysics Inc. of Oakville, Ontario. Insight employed several subcontractors to fulfill various roles. The main responsibilities were as follows:

- Insight Geophysics Inc., Oakville, Ontario (Craig Pawluk, Dennis Morrison, David Dawson, field crew)
  - project management
  - acquisition, processing and inversion of Insight sections
  - internal survey report
- Exsics Geophysics, Timmins, Ontario (John Grant, field crew)
  - acquisition and processing of pole–dipole induced polarization data and magnetic data
- Allan Spector & Associates, Toronto, Ontario (Allan Spector)
  - acquisition and processing of gravity data
  - internal survey report

- Paterson, Grant & Watson Limited, Toronto, Ontario (PGW)
  (Edna Mueller, Stephen Reford, Karl Kwan, Ron Mertens)
  - quality assurance and quality control of data acquisition
  - processing and inversion of pole–dipole induced polarization data
  - preparation of final products
- Dean Rogers and Tom Savage Drafting (Dean Rogers, Tom Savage)
  - preparation of geological models

In addition, several people assisted the team in executing the project, including Robert Calhoun (Project Manager, Discover Abitibi Initiative), Tom Watkins (Team Leader, Publication Services, Ontario Geological Survey) and various geologists with knowledge of the properties that were surveyed.

DATA ACQUISITION: GENERAL

The data were acquired during the period October 2004 to January 2005. The survey lines at each of the sites had previously been cut and picketed under a separate contract. The 4 survey methods (Insight Section, pole–dipole induced polarization, magnetic and gravity) were carried out separately by different crews, to minimize any interference. In some cases, access to the sites required extensive co-operation from the property holders, as the profiles were located across or adjacent to active mining operations.

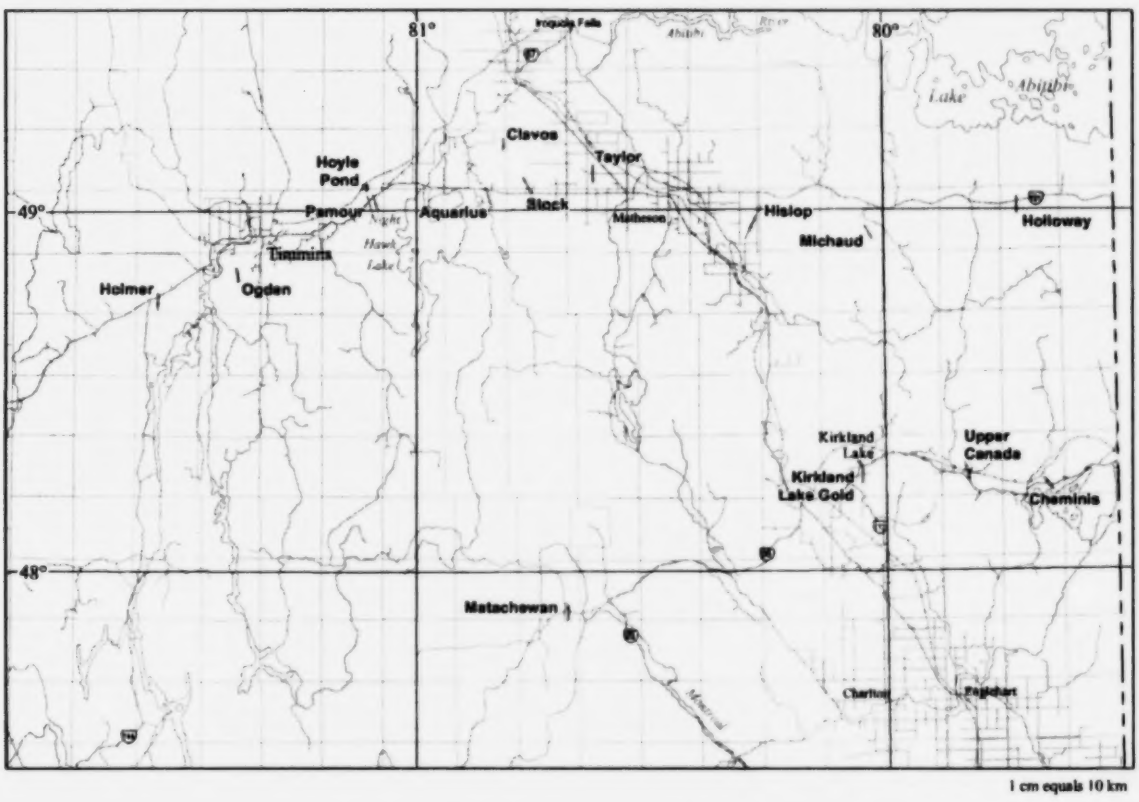


Figure 1. Location of the ground geophysical surveys at 15 sites.

The survey grids were established by Hussey Geophysics and surveyed by Total Exploration Inc. A metric co-ordinate system was utilized, referenced to local historic geologic information. The grid lines were secant chained prior to electronic surveying methods. The line direction was specific to each site, chosen to traverse perpendicular to the target geology. The line separation for the 3 survey lines was usually 100 m, with picketed stations at 25 m intervals. The typical line lengths were 3.0 km for the centre line and 2.5 km for the two flanking lines. The station locations were measured by global positioning system (GPS) during the gravity survey, using North American Datum 1983 (NAD83) in Universal Transverse Mercator (UTM) Zone 17N co-ordinates.

DATA ACQUISITION: MAGNETIC

The magnetic data were acquired using a GEM-19 Overhauser magnetometer. All lines were surveyed at each site. A station interval of 12.5 m (paced between the 25 m-spaced pickets) was utilized. A GEM-19 magnetometer was employed as a base station to monitor and correct for diurnal variations.

DATA ACQUISITION: GRAVITY

The gravity data were acquired using a Sodin 286-T gravimeter. All lines were surveyed at each site. A station interval of 50 m was utilized. The location and station elevation were determined using a GPS unit.

The gravity measurements were all made by Dr. Allan Spector, assisted by either Kevin Wilson or Cory Anthony of Timmins, in the period October 25 to November 20, 2004 (26 days). 2400 measurements were made using the thermostatically controlled gravimeter, which rested on a 0.7 m high tripod. The temperature setting was 25°C. The instrument has a 0.01 mGal sensitivity.

Surveying consisted of traverses beginning and ending at a common point. Table 1 provides a list of misclosures for each of the traverses.

Misclosures were corrected by linear proration. All surveying was tied to the Canadian Gravity Standardization Network by double readings at the following control stations:

- 9021-1984 (Kirkland Lake)
- 9656-1970 (Highway 101)
- 9610-1970 (west of Timmins).

The gravity operations were preceded by a differential GPS survey conducted by Total Exploration Inc of Timmins under the supervision of Ken Pye. An Ashtech Promark II single frequency system was used to determine the X-Y-Z position of each gravity station location. A base station was established in the vicinity of each grid. Determinations were made in 10-minute measurement periods. Post processing was done at the completion of each grid. Positional errors varied from 0.02 to 0.25 m depending on the density of tree cover. 0.1 m accuracy was maintained in over 60% of the determinations. Control for each grid was established by reference to the Geodetic Survey of Canada database, with an accuracy of 0.05 m vertical. Data were reported as based on the Canadian Spatial Reference System (CSRS) NAD83 model.

Table 1. Gravity survey misclosures.

Date	Misclosure (milligals)	Area
10/25	0.09, 0.12	Holmer
10/26	0.13, 0.12	Holmer, Pamour
10/27	0.14, 0.06	Pamour
10/28	0.14, 0.02	Aquarius
10/29	0.03, 0.11	Aquarius, Taylor
10/30	0.09	Taylor
11/01	0.01, 0.04	Taylor, Michaud
11/02	0.16	Michaud
11/03	0.15	Hislop
11/04	0.10	Hislop
11/05	0.02	Hislop
11/06	0.12	Stock
11/07	0.02	Stock
11/08	0.09, 0.05	Clavos
11/09	0.03	Clavos
11/10	0.12	Newmont
11/11	0.00	Ogden
11/12	0.14	Ogden
11/13	0.06, 0.13	Hoyle Pond, Holloway
11/14	0.01	Holloway
11/15	0.01, 0.10	Kirkland Lake Gold
11/16	0.08, 0.02	Kirkland Lake Gold
11/17	0.06	Cheminis
11/18	0.10, 0.12	Matachewan
11/19	0.05, 0.02	Matachewan, Upper Canada
11/20	0.02, 0.13	Upper Canada

Table 2. Insight array section lines and coverage.

Profile Name	Line	Extent	Extent	Total (m)
Holmer	L48E	6425 N	8950 N	2525
Ogden	L0	1950 S	0	1950
Hoyle Pond	L1E	1050 S	1000 N	2050
Pamour	L1E	1125 S	1100 N	2225
Aquarius	L139E	2150 N	4625 N	2475
Clavos	L3W	1250 S	1250 N	2500
Stock	L0	250 N	2750 N	2500
Taylor	L0	1250 S	1250 N	2500
Hislop	L0	2400 S	2525 N	4925
Michaud	L101E	9050 N	11550 N	2500
Holloway	L0	1250 S	1250 N	2500
Cheminis	L1E	1300 S	1225 N	2525
Upper Canada	L34W	1600 S	975 N	2575
Kirkland Lake Gold	L0 and L1W[1]	2700 S	900 N	3600
Matachewan	L40E	1200 S	1300 N	2500
	Total			39850

[1]Southern portion of line on L0, northern portion on L1W due to logistics.

DATA ACQUISITION: INSIGHT SECTIONS

Personnel

Dennis F. Morrison, CEO
David J.W. Dawson, Chief Geophysicist
Craig Pawluk, P. Geo., President
Marcio Maia, Principle Operator, B.Sc.
Nick Lepage
Mason Stanger
Charlie Wabie
Joe Wabie
Ryan Polson
Ryan Barlow
Fred Audet
Rick Fleming

Survey Coverage

Table 2 contains the line extents of the survey coverage. They do not include repeated readings in the total distance calculations. The Insight Sections were acquired on a single line at each site, typically the centre line.

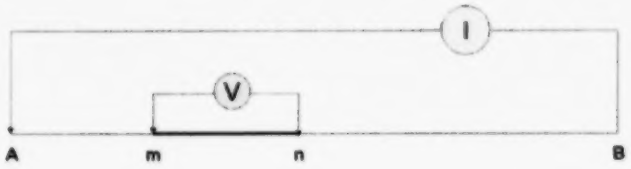
Survey Specifications

Survey type:	Time-Domain Induced Polarization/Resistivity
Array type:	Insight Array
Array:	Unconfined inline 4 electrode array
AB (Transmitter dipole spacing):	Multiple AB dipoles
Levels per section:	up to 25
mn (Receiver dipole spacing):	25 m/50 m
Sampling Interval:	25 m
Receiver:	ElrecIP Pro
Transmitter:	Modified Huntec 7.5 kVa Walcer Geophysics Inc.
Transmitted waveform:	Square wave @ 0.0625 Hz (4 s pulse) 50% duty cycle (Time Domain)
Receiver sampling (off time):	20 semi-logarithmic windows (Table 3)
IP measured parameter:	Chargeability in mV/V
Resistivity measured parameters:	Primary Voltage in mV and Transmitted Current in mA

Table 3. Insight array receiver sampling windows.

Window	Width (ms)	Window	Width (ms)
M Delay	160	11	160
1	80	12	160
2	80	13	160
3	80	14	160
4	80	15	320
5	80	16	320
6	80	17	320
7	80	18	320
8	80	19	320
9	160	20	320
10	160	**Total**	3680 (3.68 s)

Figure 2 provides the formulae used to compute the apparent resistivity for the Insight Sections.



$$\kappa \equiv 2\pi\left(\frac{1}{Am} - \frac{1}{mB} - \frac{1}{An} + \frac{1}{nB}\right)^{-1}$$

$$\rho_a \equiv \frac{\Delta V_{mn} \cdot \kappa}{I}$$

Figure 2. Calculation of apparent resistivity for Insight Sections.

The following formulae, based on those provided in Figure 2, are used to compute the apparent resistivity value at a particular location in the Insight Section, and are formatted for use in a Microsoft® Excel workbook.

2π/k = 2*3.14/((1/(ABS(SQRT(I14^2+(E14-G14)^2)))-1/(ABS(SQRT(I14^2+(F14-G14)^2)))-1/(ABS(SQRT(I14^2+(E14-H14)^2)))+1/(ABS(SQRT(I14^2+(F14-H14)^2)))))

Reference order: A B m n Δy. Units dictate denominator in eventual apparent resistivity calculation.

Recalculated apparent resistivity = ABS(O14*J14/(P14))

Reference order: Vp (mV) I (current in mA). Units ohm (Ω).

where ABS = absolute value; SQRT = square root; ^2 = squared; E14 = column–row reference

DATA ACQUISITION: POLE–DIPOLE

The conventional induced polarization survey employed a pole–dipole array to measure the chargeability and apparent resistivity. All lines were surveyed at each site. The survey parameters were

Transmitter:	Huntec 7.5 kVA Walcer Geophysics Inc.
Receiver:	Elrec 6
mn electrode spacing:	50 m
N =	1 to 6
Survey dates:	October 2004 through January 2005

DATA PROCESSING: MAGNETIC

The magnetic data were corrected for diurnal variation using the base station magnetometer data. A minor degree of editing was required to remove obvious spikes. The data were archived in Geosoft®-format binary databases and ASCII xyz files.

DATA PROCESSING: GRAVITY

The standard corrections to determine the terrain-corrected Bouguer gravity were applied as follows:

- Instrument Scale Correction – Instrument readings were converted to milligals using the instrument constant 0.10062 mGal/instrument division.
- Latitude Correction – The data were corrected for latitude variation using the 1967 Geodetic Reference System (GRS67) theoretical gravity formula.
- Elevation Correction – Gravity decreases rapidly with distance from the centre of the Earth. This decrease is also partly dependent on the density of the material underlying the gravity station. The elevation correction may be written as $+ 0.3086 - 0.04186\rho$ mGal/m, where ρ is the density of the material between the gravity station and the minimum elevation of the survey. The selected density was 2.67 g/cm^3, which is the standard for Archean terrane in Canada.
- Tidal Correction – All gravity readings were corrected for Earth tides using the formula published by Nakai (1979).
- Terrain Correction – Where needed, gravity measurements were corrected for topography using the Hammer method (Zones B and C). This is facilitated by a United States Geological Survey computer program (DOS-based) written by Tien Grauch entitled "HAMMER". A Vaisala digital barometric altimeter was used to determine the elevation of topographic features neighbouring a gravity station.

The data were archived in Geosoft® format binary databases and ASCII xyz files.

For presentation purposes, a residual Bouguer gravity field was computed for the back-pocket chart, so the local variations in the gravity response could be better appreciated. A second-order (or rarely third-order) trend was computed and removed from the Bouguer gravity to provide the residual.

DATA PROCESSING AND INVERSION: INSIGHT SECTIONS

Processing of the Insight IP data was handled with 2 software packages:

- Prosys software from IRIS Instruments was used to recover raw data from the instrument and edit out spurious readings. It produces a binary and an ASCII text export. A raw binary file was recovered from the ELREC Pro receiver, once per day. It can be viewed and exported to an ASCII (*.csv*) file using Prosys software. (www.iris-instruments.com/Support/Download/Download_geophy.html)
- Oasis montaj™ from Geosoft® Inc. was used to compile and perform quality control on the data in a database format. It produces a database and an ASCII xyz format export (total chargeability, apparent resistivity, grid co-ordinates) as a final digital product. All map products were generated with the mapping portion of this package. (www.geosoft.com/pinfo/oasismontaj/index.asp)

The Insight Section is a method of presenting the large volume of data collected in multiple array configurations and acquisition sections (approximately 1 km in length) that overlap down the survey line. Figures 3a to 3d show a representative Earth model of apparent resistivity and chargeability, and the corresponding Insight Sections. It is apparent that the Insight Section shows more direct correspondence with geology than a typical pseudo-section, but still requires interpretation.

All Insight Section array data are presented in standard Insight Section format as well as University of British Columbia Geophysical Inversion Facility (UBC–GIF) DCIP2D inversion program (DCIP2D 1998) output. Substantial time and effort was put into the inversion process. Insight would especially like to thank Peter Rowston, Feicim Pty. Ltd. (parowston@iprimus.com.au) for his timely help and access to the alt.DCIP2D suite of DCIP inversion software. Due to time constraints, the Insight Section inversions presented on the back-pocket charts were prepared using the UBC software. Figures 4, 5 and 6 present a

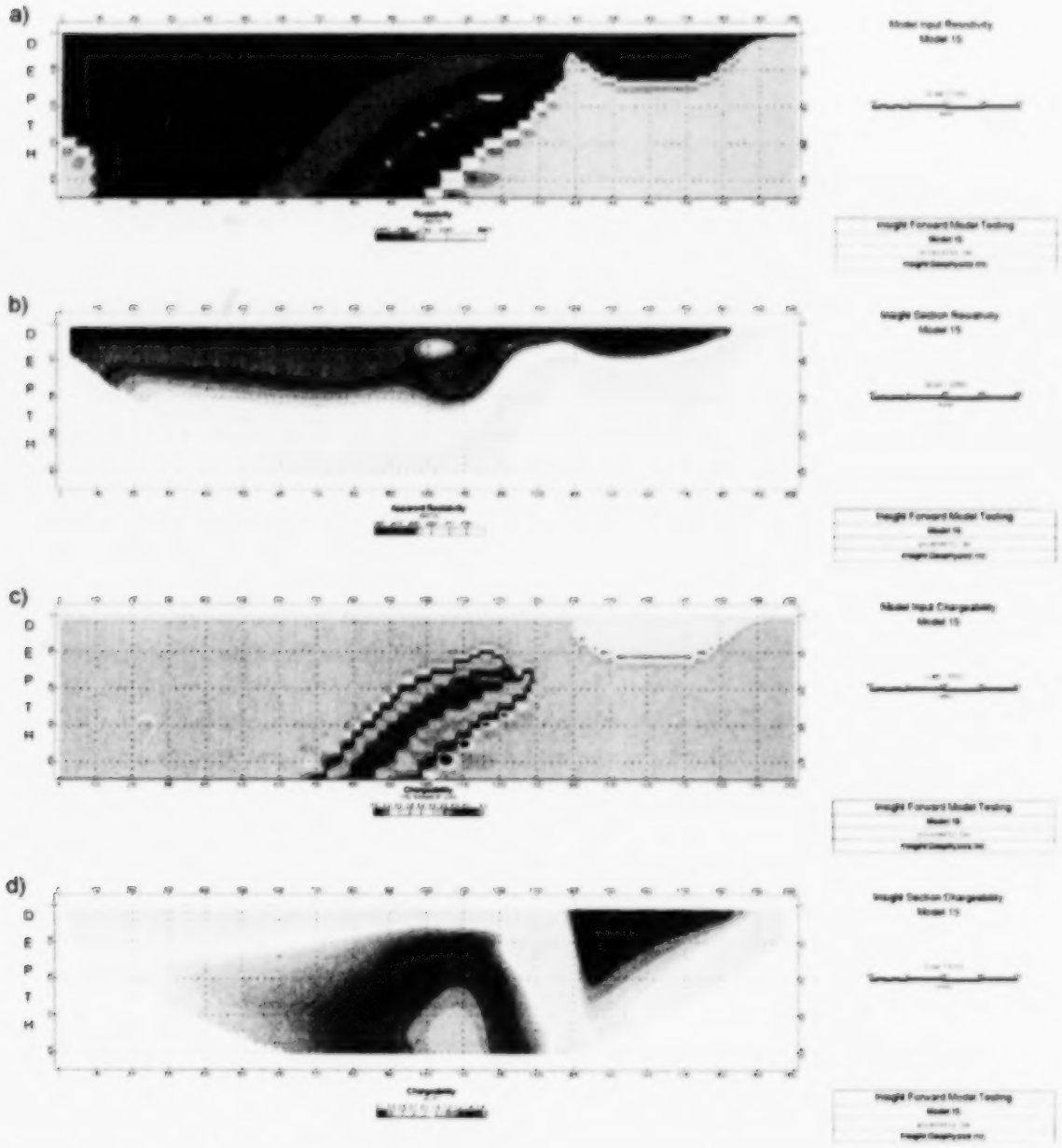


Figure 3. **a)** Earth model of apparent resistivity; **b)** Insight Section of apparent resistivity corresponding to Earth model in (a); **c)** Earth model of chargeability; **d)** Insight Section of chargeability corresponding to Earth model in (c).

comparison for the Insight Section, alt.DCIP2D and UBC–GIF DCIP2D presentations from the Michaud site. The UBC resistivity inversion result in Figure 6 differs in some of its details with that displayed on the Michaud back-pocket chart. This is due to a different weighting scheme applied to the model mesh for the two inversions. The two results are equally valid.

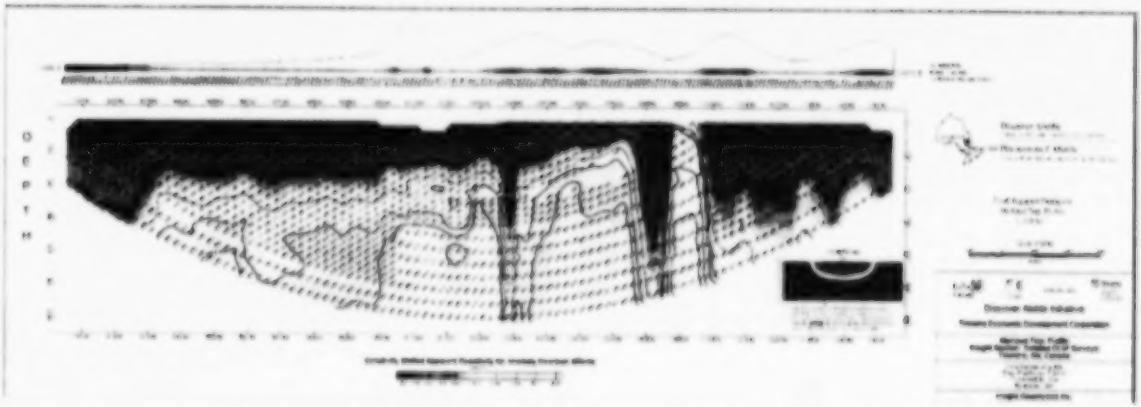


Figure 4. Insight Section presentation for the apparent resistivity section, Michaud site.

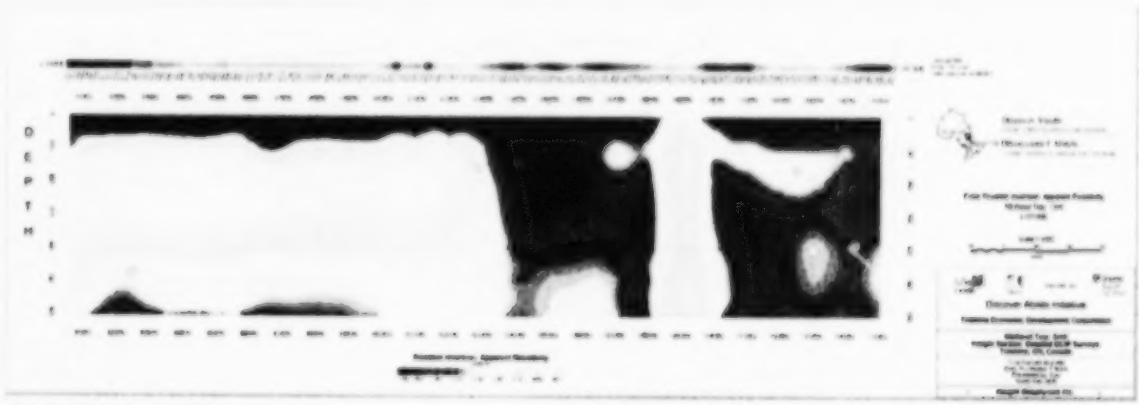


Figure 5. alt.DCIP2D inversion for the apparent resistivity section, Michaud site.

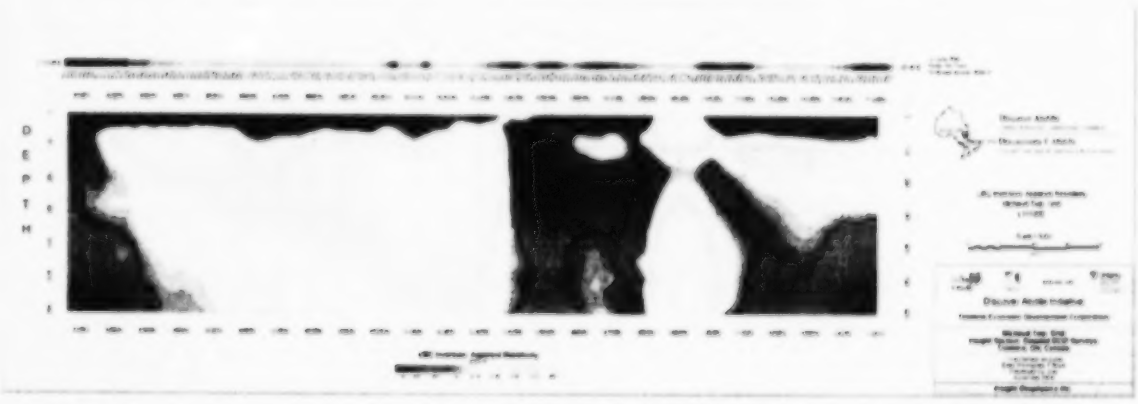


Figure 6. UBC–GIF DCIP2D inversion for the apparent resistivity section, Michaud site.

Each profiled survey line is presented in the following formats:

- Insight Section Apparent Resistivity
- Insight Section Chargeability

Raw data are plotted using the Insight Section plotting presentation. Total chargeability calculated by the ELREC Pro receiver is used as standard. Both chargeability and apparent resistivity may be culled for spurious effects detracting from the overall presentation. Spurious effects may include anomaly inversion interaction with highly contrasting, near-surface targets (Loke 2002). During the project, Insight Geophysics developed the Insight Sounding (InSndg) process using MATLAB® software. When applicable, this process may be used to remove these high frequency effects. All raw data are archived in ASCII CSV format.

- UBC–GIF Apparent Resistivity DCIP2D Inversion result
- UBC–GIF Chargeability DCIP2D Inversion result

The Insight Section Array is extremely effective in producing high-density DCIP measurements. Survey design allows for the direct acquisition of numerous symmetrical and asymmetrical (approaching) three- and four-electrode arrays. All geometries are entered into the inversion stream.

Both processing streams (Insight Section and UBC–GIF DCIP2D inversion presentations) are considered interpretative.

DATA PROCESSING AND INVERSION: POLE–DIPOLE

Preliminary pseudo-sections of the pole–dipole chargeability and apparent resistivity were prepared using the Geosoft® IP Processing System. Obvious data errors were edited prior to creating the final pseudo-sections. The chargeability and apparent resistivity were inverted using the UBC–GIF DCIP2D inversion software. The inverted sections were truncated at a depth of 200 m. The actual depth penetration of the survey varies with the overburden and geological conditions, and is usually less than 200 m for a survey with 50 m electrode spacing and n = 1 to 6.

The pseudo-sections for the pole–dipole data acquired on the same survey line as the Insight Section are presented on the back-pocket charts. The pseudo-sections for all survey lines, and the associated inversion results, are provided with the digital data.

QUALITY ASSURANCE AND QUALITY CONTROL

There were several stages of quality assurance and quality control (QA/QC), summarized as follows:

1. Each survey crew implemented its QA/QC procedures in the field, as instituted by its survey contractor. The data were reviewed each evening.
2. Ron Mertens of PGW undertook a QA/QC visit, and observed the field operations of each survey crew.
3. The data compilation and processing by each contractor incorporated QA/QC for data errors.
4. All data were reviewed by PGW in preparation of the back-pocket charts and the digital data.

The Insight Section Array allows for efficient high data-density acquisition. This data density allows for a more statistical approach to quality control and post processing. The following is a list of obstacles encountered during the Discover Abitibi Initiative and a brief description of the solution.

Taylor Profile

- Average standard error = 0.114847
- Average contact resistance (k ohm) = 0.78771

No unusual concerns.

Clavos Profile

- Average standard error = 0.683524
- Average contact resistance (k ohm) = 0.307234

The power corridor located near 8+00S on the Clavos Profile strongly influenced the chargeability measurements. This was corrected for by using the InSndg process. The apparent resistivity required no post processing.

Aquarius Profile

- Average standard error = 0.839813
- Average contact resistance (k ohm) = 17.04861

The Aquarius Profile lies along Gibson Lake Road and has areas of heavy glacial till cover. Generating sufficient Vp to produce reliable chargeability measurements was difficult. Best effort was put forth to improve current injection pits. The results of this effort still led to a heavily culled chargeability section. The Vp levels were sufficient to collect good quality apparent resistivity data.

Holloway Profile

- Average standard error = 0.064416
- Average contact resistance (k ohm) = 0.135741

The Holloway Profile encountered current channelling due a strong crosscutting fault located near 12+50N. The chargeability and apparent resistivity sounding curves were extrapolated for final Insight Section presentation.

Michaud Profile

- Average standard error = 0.386449
- Average contact resistance (k ohm) = 1.106644

The Michaud Profile DCIP parameters were corrected with the InSndg process for a strong subcropping feature located near 109+00N.

Stock Profile

- Average standard error = 0.220219
- Average contact resistance (k ohm) = 0.858333

No unusual concerns.

Hislop Profile

- Average standard error = 0.421566
- Average contact resistance (k ohm) = 0.134066

A shallow, cathodic pipeline near 15+25N caused minor problems.

Upper Canada Profile

- Average standard error = 4.285581
- Average contact resistance (k ohm) = 9.441288

Strong near surface (cultural?) features affect the chargeability measurements between 0 and 500N on this profile. These data are presented in raw format as there is potential that there is near-surface mineralization of interest in the area of the mine.

Ogden Profile

- Average standard error = 1.078476
- Average contact resistance (k ohm) = 1.191133

No unusual problems encountered. Minor problems with low Vp levels due to difficult current injection locations.

Cheminis Profile

- Average standard error = 0.683127
- Average contact resistance (k ohm) = 8.838372

No unusual problems encountered. Strong near-surface feature near 50N remains in data set.

Matachewan Profile

- Average standard error = 0.745449
- Average contact resistance (k ohm) = 10.91228

No unusual problems encountered. Strong near-surface features remain in data set.

Holmer Profile

- Average standard error = 1.1706
- Average contact resistance (k ohm) = 12.18914

No unusual concerns.

Pamour Profile

- Average standard error = 0.871393
- Average contact resistance (k ohm) = 17.58372

No unusual concerns. Minor anomaly inversions due to current injection locations remain in data set.

Hoyle Pond Profile

- Average standard error = 1.148822
- Average contact resistance (k ohm) = 6.827565

Nothing that was not unusually concerning. The profile crosses the back door of the Kidd Creek Metallurgical Site and tailings pond infrastructure. Intense cultural environment. Data are presented in raw format. Data missing due to portal to ramp at the Hoyle Pond Mine.

Kirkland Lake Gold Profile

- Average standard error = 4.689817
- Average contact resistance (k ohm) = 12.35247

Nothing that was not unusually concerning. Profile crossed Chaput Hughes and various cultural corridors. L0 was surveyed for the southern block of data. L1W was surveyed for the north due to concerns of residential housing.

The Insight Section Array utilizes a distributed array of 40 channels. Special attention is taken to ensure best possible contact resistance (k ohm) prior to acquisition. Approximately 16% of the data were repeated and saved in the field for quality-control purposes.

When logistically possible, Insight Sections to be stitched were overlapped by a minimum of one, but typically two dipoles. Survey design allowed for minimal levelling for stitched sections due to non-common injection locations. Single mn station gaps in survey data usually indicate crossing a major highway.

Figure 7 provides an example of decay analysis, comparing theoretical and measured decay over time, to ensure that the Insight system is working properly.

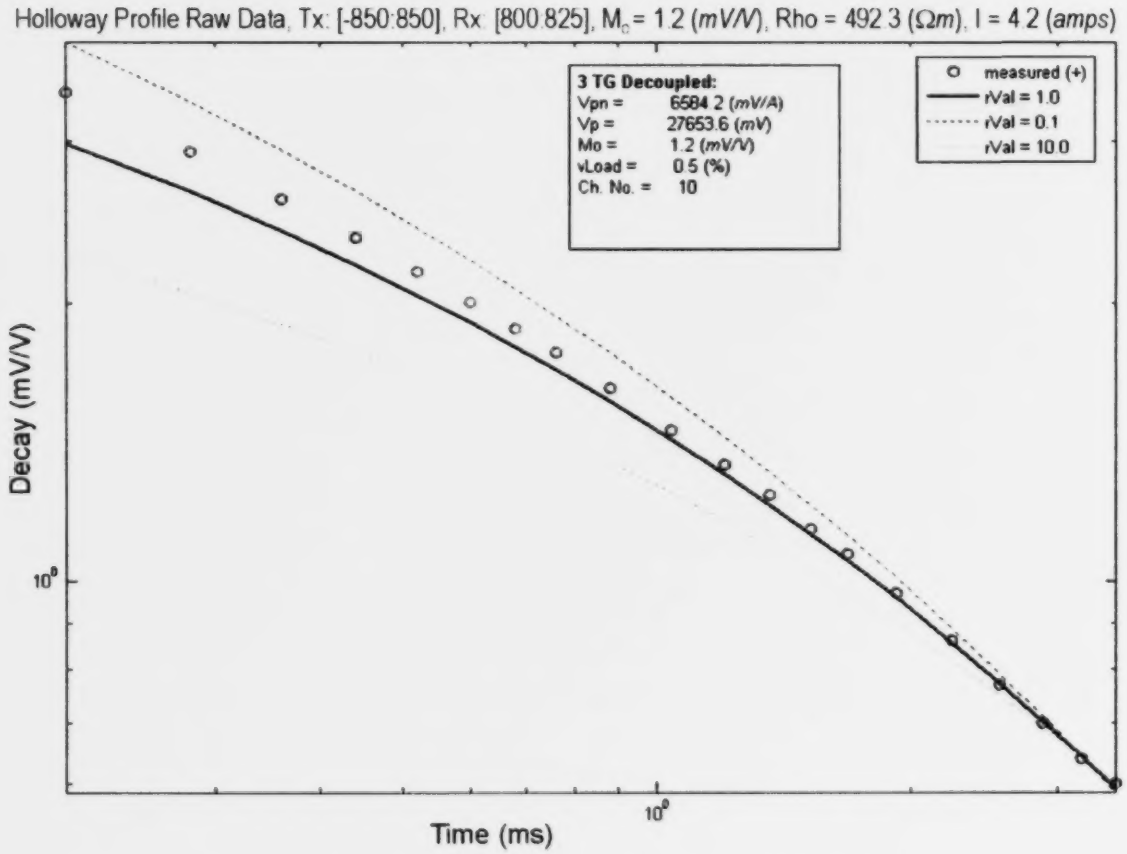

Holloway Profile Raw Data, Tx: [-850:850], Rx: [800:825], M_o = 1.2 (mV/V), Rho = 492.3 (Ωm), I = 4.2 (amps)
3 TG Decoupled:
Vpn = 6584.2 (mV/A)
Vp = 27653.6 (mV)
Mo = 1.2 (mV/V)
vLoad = 0.5 (%)
Ch. No. = 10
measured (+)
rVal = 1.0
rVal = 0.1
rVal = 10.0
Decay (mV/V)
10^0
10^0
Time (ms)

Figure 7. An example of field decay curve analysis using Halverson Wait criteria.

PRODUCTS

The core products of the project are

1. This report, which incorporates 15 back-pocket charts.
2. The corresponding Miscellaneous Release—Data 202 (Dawson et al. 2006), which includes all of the data acquired for the project, in raw and processed form, and 5 regional maps (*see below*).

One back-pocket chart was prepared for each of the 15 survey sites consisting of the data for the entire survey line (usually the centre line) where the Insight data were acquired. Each back-pocket chart incorporates the following elements:

1. Elevation profile with annotated topographic and cultural elements
2. Profile of total magnetic field, Bouguer gravity field and residual Bouguer gravity field
3. Insight Section of apparent resistivity
4. UBC–GIF DCIP2D inversion of apparent resistivity
5. Insight Section of chargeability
6. UBC–GIF DCIP2D inversion of chargeability
7. Pseudo-sections of apparent resistivity and chargeability from the pole–dipole survey
8. Representative geological section

Elements 1 to 7 listed above were assembled from the survey data acquired for the project. The geological section for each site was compiled from data acquired from the property holders. The location, orientation, length, depth, quality and accuracy of each geological section vary depending on the surface mapping and drill hole data available. The user must take these factors into account when comparing the geophysical data to the geological section.

The regional maps were prepared mainly from data published by the Ontario Geological Survey, much of which were acquired and/or compiled under the Discover Abitibi Initiative. They provide the geological and geophysical setting for the survey sites. The map elements are

1. Bedrock geology (Ayer, Trowell and Josey 2004)
2. Residual magnetic field
3. Electromagnetic field apparent conductance/conductivity
4. Bouguer gravity field
5. Digital elevation model

Regional Geological and Geophysical Setting of the Profile Sites

The 5 regional maps listed in the previous section provide the context for the ground geophysical surveys and the geological sections covered by this report. The bedrock geology provides a perspective on the setting, structure, strike and other features that are critical to the understanding of the geological sections and the interpretation of the ground geophysical data. The regional geophysics not only provide information on the physical properties of the mapped geology, but indicate where certain units underlie those mapped at surface and also trace structural features. The regional magnetic and gravity data are useful for interpreting some of the ground anomalies (depending on resolution). The electromagnetic conductance is useful for discrimination of the conductive or resistive units mapped by the Insight and pole–dipole resistivity data, particularly to differentiate between a lithologic response and that due to mineralization.

Profile Results

The profile results are presented on the back-pocket charts for one survey line (usually the center line). The digital data for the other two lines are included Miscellaneous Release—Data 202 (Dawson et al. 2006). When comparing the geophysical data on the back-pocket charts with the geological sections, refer to the note for the location of the assumed or modeled geology relative to the survey line.

HOLMER

The survey line presented on the back-pocket chart is 48+00 E. The geological section is from line 47 + 00 E, located 100 m to the west.

The survey lines straddle the northeast-striking contact between clastic metasedimentary rocks to the south and mafic metavolcanic rocks (massive flows) to the north. Locally, there is an embayment of the metasedimentary rocks to the north, offset along the Bristol fault. The fault dips north at 52°. The metavolcanic rocks lie on the footwall side of the fault, and host pockets of mineralized metasedimentary and mafic metavolcanic rocks.

The contact between the conductive metasedimentary and resistive metavolcanic rocks at the Bristol fault is well defined in the Insight and pole–dipole resistivity sections. The eastern contact of this metasedimentary unit is apparent as well. The lower density of the metasedimentary rocks produces a negative gravity anomaly. The upper mineralized zone, at 300 to 400 m below surface, produces a clear chargeability anomaly in the Insight Section (7880 N). A similar anomaly at 8130 N is centred at 500 m below surface. It is apparently not drilled (bearing in mind the offset between the Insight Section and geology section), and may represent a new target.

A strong magnetic anomaly (nearly 5000 nT), centred at 7210N, correlates with an ultramafic horizon. There is a strong chargeability anomaly in the hanging wall of the bounding metavolcanic rocks to the north, apparent in both the Insight and pole–dipole data. A weaker Insight chargeability anomaly is centred on the ultramafic unit itself. These may be indicators of mineralization.

The thicker overburden above the metasedimentary rocks is apparent in the Insight Section as a conductive surface horizon with low chargeability.

OGDEN

The survey lines cross the east-northeast-striking Porcupine–Destor fault, which marks the contact between mafic metavolcanic rocks (massive and pillowed flows) to the north and intermediate to felsic metavolcanic rocks to the south. The airborne magnetic data show several bands of iron formation in the area, but the survey lines are located in a "dead zone" in between them.

The geological section shows the Porcupine–Destor fault dips north at 50°, whereas the geological units dip steeply to the south. Several horizons are present, mainly metavolcanic rocks that range from felsic to ultramafic.

There is a broad, flat-lying Insight chargeability anomaly that dominates the southern half of the section, roughly coincident with a zone of high resistivity. The shallower north end is also evident in the pole–dipole data, partly obscured by a gap in the data. The strongest part of the anomaly is focussed on the hanging wall of the Porcupine–Destor fault, but extends south well into the footwall. The hanging-wall portion coincides with a gravity high, indicative of the local gradation from felsic metavolcanic rocks, in the south, to mafic to ultramafic metavolcanic rocks, in the north.

Both the Insight and pole–dipole data show a shallow chargeability anomaly at the south end (1820 S), coincident with a zone of quite high resistivity, and appears to be located in the footwall beneath the contact with an ultramafic unit.

A zone of higher conductivity cuts the section at 900 S, before reverting to moderate chargeability and resistivity in the northern part of the section. There is no geology with which to correlate these responses, but the gravity lows at 900 S and 500 S suggest metasedimentary or felsic metavolcanic horizons, with a more mafic unit in between.

There may be some cultural effects in the vicinity of the mine at the north end of the profile, particularly on the magnetic and Insight data. There is a chargeability anomaly at 70 S in both the Insight and pole–dipole data, near the shaft, although the inversion indicates that it is a surface effect (i.e., cultural).

Many parts of the section show a more conductive horizon below 400 m in the Insight resistivity data.

The overburden is apparent in the Insight Section as a conductive surface horizon with low chargeability. It appears to thicken to the north.

HOYLE POND

The survey lines extend from clastic metasedimentary rocks, in the south, across mafic to intermediate metavolcanic rocks, in the north, incorporating an ultramafic horizon. The geology strikes approximately east. The Pamour grid adjoins the Hoyle Pond grid to the south-southeast.

The geological section shows the mafic and ultramafic rocks dip steeply to the north in the southern half of the section, bounded by Porcupine assemblage metasedimentary rocks (labelled "Porcupine sediments" on geology section on back-pocket chart) to the north and south. The mafic metavolcanic rocks are cut by the 1060 fault and a diabase dike, both dipping steeply to the south.

The strongest Insight chargeability anomaly, centred at 70 S, 100 m below surface, is roughly coincident with the Hoyle Pond veins (labelled "HP Veins"), which are located towards the eastern side of the anomaly. It is also coincident with a zone of higher conductivity. These data suggest that the area below and west of the veins, near the contact with the ultramafic unit, should also be prospective targets.

There is a chargeability anomaly at the south end of the profile, where a vertical offset along the 1060 fault is evident in the Insight data. The hanging-wall portion of the mafic metavolcanic rocks along the fault is quite conductive, and is likely related to the nearby graphitic structure.

Where there is a gap in the Insight data, the pole–dipole data indicate a shallow zone of high chargeability and high resistivity in the ultramafic unit. The magnetic anomaly centred at 350 S is due to the ultramafic unit (and possibly the diabase dike).

The overburden is marked by a conductive horizon in the northern part of the section, evident from the Insight resistivity data.

PAMOUR

The survey lines cross several horizons striking east-northeast. From south to north, they are clastic metasedimentary, ultramafic intrusive, Timiskaming-type clastic metasedimentary, ultramafic to mafic metavolcanic and, again, clastic metasedimentary rocks. The Hoyle Pond grid adjoins the Pamour grid to the north.

The geological section shows the above-mentioned horizons in more detail, generally dipping north (steep to 45°). It is cut by diabase dikes (striking virtually parallel to the survey lines), and a portion of the Porcupine–Destor fault.

There is a prominent chargeability anomaly with coincident high conductivity near the south end of the section, which correlates very well with the Porcupine–Destor deformation zone, both in location and geometry.

All of the rocks north of the diabase dike, with the exception of the Porcupine assemblage metasedimentary rocks at the far north end, are relatively resistive. The hanging wall of the Timiskaming assemblage metasedimentary rocks, above the diabase dike, shows a chargeability anomaly. A strong, discrete chargeability anomaly at 400 N is located in the mafic to ultramafic metavolcanic rocks, at the contact with the conglomerate.

The pole–dipole data agree quite well with the shallow portions of the Insight data. At depth, there are indications of discrete zones of chargeability and resistivity in the Insight data.

The gravity data show, from south to north, a high over the Tisdale assemblage ultramafic rocks, a low over the Porcupine–Destor deformation zone and diabase dike, an elevation over the Timiskaming assemblage metasedimentary rocks, a high over the mafic and ultramafic metavolcanic rocks and a low over the Porcupine assemblage metasedimentary rocks. There is significant magnetic activity over the Timiskaming assemblage metasedimentary units and discrete anomalies over some of the metavolcanic units.

The overburden is evident as a thin conductive horizon across most of the section in the Insight resistivity data.

AQUARIUS

The survey line presented on the back-pocket chart is 139+00 E. The geological section is from line 140 + 00 E, located 100 m to the east.

The survey lines, from south to north, traverse broad horizons of mafic to intermediate metavolcanic rocks, and ultramafic intrusive rocks, followed by a narrow band of clastic metasedimentary rocks and a broader horizon of Timiskaming-type clastic metasedimentary rocks. These rocks strike east-northeast.

The geological section consists of pillowed mafic metavolcanic rocks in the south and bands of talc-chlorite schist and sediments in the north. The section is cut in the middle by a 400 m wide fault and shear zone (including the Gold Island fault) with units of porphyry, mafic metavolcanic rocks, talc, carbonate and mixed rocks dipping steeply to the south.

The conductive zones in the Insight data, both near surface (below the overburden) and at depth, correlate well with the talc-schist units, and perhaps the carbonate on the north side of the fault and shear zone. The entire fault zone is low in chargeability.

There is a moderate chargeability anomaly at depth in the northern part of the section, mainly over the Timiskaming-type clastic metasedimentary rocks. The tapering of the anomaly to the south suggests that a thrust fault may bond the sediments with the overlying talc-chlorite schist.

A weak chargeability anomaly between 3600 N and 3700 N may indicate mineralization on the talc-chlorite schist, at the footwall of the fault zone. There is a magnetic anomaly on the south edge of this zone.

The gravity profile shows a steady decrease from south to north. The residual gravity field shows discrete anomalies over several units, including a high over the northern part of the mafic metavolcanic rocks, lows over the talc-chlorite schists and highs over the Timiskaming-type clastic metasedimentary rocks and the carbonate in the fault zone. The fault zone also results in a magnetic anomaly south of the carbonate.

The overburden results in a fairly thick section of conductive material, with shallow units of resistive and/or chargeable material.

CLAVOS

The survey lines are located mainly over clastic metasedimentary rocks. At the south end, the lines traverse a sliver of mafic intrusive rocks and, at the north end, cross the Pipestone fault into ultramafic (and mafic) metavolcanic rocks. The rocks strike east.

The geological section indicates the presence of an additional mafic horizon towards the south end, and provides details on the geometry and lithologies associated with the Pipestone fault. All rocks are steeply dipping.

The Insight chargeability data show a fairly uniform section at depth. Closer to surface, the sedimentary horizon towards the south (700 S to 950 S) is extremely low in chargeability, with a steep south dip evident, and is generally resistive as well. A similar, but much smaller, anomaly is located at the

extreme north end of the profile, although it is located in an area mapped as metavolcanic rocks. There are 3 broader zones of higher chargeability in the upper 200 m:

- 375 S to 600 S – correlates with a mafic horizon, and extends into the metasedimentary rocks to the north, somewhat conductive
- 525 N to 675 N – located in the metasedimentary rocks, resistive
- 900 N to 1150 N – located mainly in the footwall metavolcanic rocks of the Pipestone fault, somewhat conductive

The Insight resistivity data show a fairly well-defined interface at 750 S, between resistive to the south and conductive to the north, extending to depth with a northerly dip. This may indicate the contact between the metasedimentary rocks (south) and mafic horizon (north).

There are 2 magnetic anomalies at the south end, one of which correlates with the ultramafic horizon. The second lies south of the geological section, and probably indicates another mafic or ultramafic horizon. The magnetic anomalies north of the Pipestone fault correlate with ultramafic (and mafic) metavolcanic rocks. The gravity profile is relatively smooth, with a positive gradient from south to north, marking the transition from metasedimentary to metavolcanic rocks across the Pipestone fault. The largest residual gravity anomaly is the high at the extreme north end of the profile, over the ultramafic (and mafic) metavolcanic rocks.

The Insight resistivity section shows a fairly conductive overburden of varying thickness.

STOCK

The survey lines traverse a wedge of rocks similar to those at the Aquarius site. They are, from south to north, ultramafic (to intermediate) metavolcanic rocks (incorporating a diabase dike), ultramafic intrusive rocks, narrow bands of clastic metasedimentary and Timiskaming-type clastic metasedimentary rocks, and finishing again in the clastic metasedimentary rocks. These rocks strike east-northeast.

The geological section at the south end of the survey line covers a fault zone that incorporates metasedimentary (greywacke), mafic volcanic and ultramafic rocks, talc-chlorite schists and diabase dikes. The faults dip steeply to the south.

There is a large Insight chargeability anomaly at depth towards the south end of the section. It shows a shallow north dip, and may underlie the deepest drill hole in the section. It could indicate footwall rocks beneath a fault (e.g., thrust fault) that cuts the steeply dipping horizons mapped above. A shallower, broad zone of moderate chargeability is located in the northern part of the section (2000 N to 2500 N), from near surface to 400 m depth. It is located in the clastic metasedimentary rocks, as indicated by the flat magnetic response.

The Insight resistivity data suggest horizontal layering, which may reflect rocks that underlie the wedge at surface. The strong magnetic anomaly at the south end correlates with a diabase dike. The elevated magnetic response in the southern half reflects the metavolcanic rocks. The contact with the clastic metasedimentary rocks to the north is well defined by the shift in the magnetic response at 1750 N. The gravity data show a smooth, decreasing gradient from south to north, indicating the transition from metavolcanic to metasedimentary rocks.

The overburden is characterized by a conductive, low chargeability horizon across the section, with an underlying resistive horizon in several places, particularly the northern half.

TAYLOR

The survey lines straddle the Porcupine–Destor deformation zone (PDDZ; labelled "fault zone PDZ" on geology section on back-pocket chart), hosting ultramafic (to mafic) metavolcanic rocks. The country rock to the south is mafic (to intermediate) metavolcanic and, to the north, is clastic metasedimentary.

The geological section shows horizons of coarse-grained mafic rocks (gabbro), pillowed and variolitic mafic rocks, porphyry and carbonate south of the PDDZ. The zone itself hosts ultramafic rocks (e.g., talcose-chloritic schist). North of the deformation zone, the Porcupine assemblage metasedimentary rocks consist of argillite and greywacke. The horizons and faults dip roughly 45° to the south, and strike east.

The northern part of the section is dominated by a broad chargeability anomaly in the Insight data. It is located in clastic metasedimentary rocks. The PDDZ (100 N to 200 N near surface, and dipping to the south) is a transition between higher chargeability in the Porcupine assemblage metasedimentary rocks (north) and metavolcanic rocks (south), with evidence of the southwards dip. The PDDZ shows a relatively high resistivity, but not as high as the metasedimentary rocks to the north. South of the PDDZ, the carbonates are more conductive, whereas the overlying mafic and ultramafic rocks are resistive.

Two small chargeability anomalies occur close to surface, centred at 280 N in the Porcupine assemblage metasedimentary rocks, and at 850 S in mafic (to intermediate) metavolcanic rocks. They are not explained in the geological section.

The ultramafic rocks in the PDDZ produce a discrete magnetic high. Several sharp anomalies occur over the pillowed metavolcanic rocks to the south. Broader highs extend further south into the metavolcanic rocks, likely with contributions from a nearby diabase dike. The gravity data show a smooth, decreasing gradient from south to north, indicating the transition from metavolcanic to metasedimentary rocks. A residual gravity high is centred over the mafic rocks south of the PDDZ (gabbro and pillowed metavolcanic rocks). A modest residual gravity low occurs over the PDDZ, with possible contributions from the adjacent metasedimentary rocks.

The surficial response shows a fairly thick layer of conductive material over a resistive horizon, and a thinner layer of low chargeability. It is likely that some of the conductive response has bled into the underlying bedrock.

HISLOP

The survey line presented on the back-pocket chart is 0+00. The geological section is from line 1+00W, located 100 m to the west.

The survey lines traverse, from south to north, mafic to intermediate metavolcanic rocks (possibly with Timiskaming-type alkalic metavolcanic and/or clastic metasedimentary rocks and/or alkalic intrusive rocks mixed in), horizons of mafic to ultramafic metavolcanic rocks, crossing the PDDZ into clastic metasedimentary rocks (wacke and mudstone/siltstone). The rocks strike southeast.

The geological section in the centre of the profile shows a series of near vertically dipping horizons, mainly metavolcanic rocks (ultramafic; massive Fe- and Mg-tholeiitic basalt; Mg-tholeiitic pillow basalt), syenite and quartz-feldspar-phyric dike, with minor amounts of lamprophyric dike, intermediate dike and clastic metasedimentary rocks.

There is a pipeline (with cathodic protection) at 1520 N, which affects the Insight and pole–dipole induced polarization, and the magnetic data. The footprint is roughly 100 m wide, varying somewhat with each method.

The chargeability and resistivity responses vary considerably across the section. The clastic metasedimentary rocks to the north show a relatively homogenous response: moderate resistivity, low chargeability (increasing to the north at depth), low gravity and flat magnetic response. There is a narrow anomaly in all parameters at 2000 N.

The zone of highest chargeability in the section stretches from 400 N to 1450 N, possibly extending to 1700 N (through the interference from the pipeline). This zone is generally conductive, but some resistive horizons are apparent. It is also characterized by a broad magnetic anomaly and slight gravity low.

The broad unit mapped as massive basalt (Fe-tholeiite) in the centre of the geological section, is moderately chargeable, and low in resistivity. The northern part of the unit produces the strongest magnetic anomaly in the section, and a residual gravity high near its northern edge. The pillow basalt south of 500 S appears to extend to 900 S or so, and is moderately chargeable, low in resistivity and somewhat active magnetically. Further south, the magnetic response is flat, indicating felsic metavolcanic rocks. South of 1700 S, there is a zone of lower chargeability, higher conductivity and a residual gravity low.

The area between 500 S and 200 S incorporates several horizons in the geological sections with complex geophysical responses. The chargeability is generally low across the area. The resistivity shows a shallow zone of high resistivity, underlain by a conductive horizon between 60 m and 190 m, and then generally more resistive below that. The shallow resistivity high may reflect the quartz-feldspar-phyric dike, but suggests a different geometry (i.e., flat-lying) than interpreted from the drilling, as does the discrete conductivity anomaly. These anomalies are coincident with a magnetic low, typical of quartz-rich rocks. The contact at 500 S, with the pillow basalt, is relatively distinct in all parameters.

The overburden is characterized by a well-defined layer of high conductivity, and associate low chargeability.

MICHAUD

The survey line presented on the back-pocket chart is 101+00E. The survey lines are centred on the Porcupine–Destor deformation zone and cross several horizons, which, from south to north, are mafic to intermediate metavolcanic rocks (massive and pillowed flows) with narrow horizons of clastic metasedimentary rocks, a mixture of Timiskaming-type clastic metasedimentary (wacke) and chemical metasedimentary rocks (oxide facies), a mixture of mafic to intermediate metavolcanic rocks (pillowed flows) and alkalic intrusive rocks, ultramafic to mafic metavolcanic rocks, mafic to intermediate metavolcanic rocks, Timiskaming-type clastic metasedimentary rocks and alkalic intrusive rocks (diorite or similar). The rocks strike east-northeast.

There are 2 drilled portions in the geological section. In the Southwest Zone, the host rock consists of greywacke with or without sandstone. Horizons of gabbro, conglomerate (thin bed) and banded iron formation were intersected. The zone is bounded to the north by ultramafic metavolcanic rocks (talcose). The dips are near vertical. To the north, in the Miller Zone, several narrow horizons of meta-igneous rocks, ranging between felsic and ultramafic, were intersected, as well as the PDDZ itself.

The most prominent anomalous zone is in the 10850 N to 11000 N area. There is a high resistivity zone from surface to 100 m below ground, and a second from 200 m and deeper, with an adjacent conductive horizon to the south. The highest chargeability occurs between 250 m and 500 m depth, and is slightly offset to the north relative to the high resistivity. They are coincident with a prominent gravity high, and a magnetic low (with a complementary magnetic high to the north). The PDDZ shows moderate conductivity and low chargeability. The zones of high chargeability appear to focus on the ultramafic rocks, whereas the high resistivity encompasses all of the rocks in the hanging wall. The magnetic low likely relates to the lower magnetic susceptibility of the rocks in the fault zone relative to the ultramafic host rocks. The Insight chargeability data suggest that the additional exploration should be focussed in the 400 m depth range.

A vertical horizon of high chargeability and high conductivity is centred at 10390 N, with a magnetic anomaly offset slightly to the north. It occurs within the ultramafic metavolcanic rocks.

A strong chargeability anomaly, with relatively high resistivity, is centred at 10120 N, and shows a slight south dip. It is located in greywacke just north of the banded iron formation. The iron formation produces the strong magnetic anomaly and weak gravity anomaly at 10080 N. There are some zones of high chargeability in the metasedimentary rocks to the south.

The southern part of the section (south of 9900 N) shows relatively homogeneous responses (low chargeability, high resistivity, flat magnetic and gravity) over the metavolcanic and metasedimentary rocks. The northern part of the section (north of 11000 N) is also fairly homogeneous (moderate chargeability and conductivity, rolling magnetic response and increasing residual gravity gradient) over the metavolcanic rocks.

The overburden is generally characterized by a conductive horizon with low chargeability. The resistive feature at surface, between 10850 N and 10980 N, correlates well with the area of outcropping bedrock in the geological section.

HOLLOWAY

The survey lines are located mainly in mafic to intermediate metavolcanic rocks. To the north, they traverse horizons of Timiskaming-type clastic metasedimentary and intermediate to felsic metavolcanic rocks. The Porcupine–Destor fault and several splays are mapped in the area. The rocks strike east (north) to east-northeast (south).

The geological section shows alternating horizons of mafic metavolcanic and metasedimentary rocks (greywacke and argillite), with one horizon of ultramafic metavolcanic rocks. Three altered zones are located within or on the contact of the mafic metavolcanic horizons. The rocks show a steep south dip.

The northernmost altered zone (800 N to 900 N) produces a shallow zone of high conductivity just below the overburden (810 N), and a chargeability anomaly that migrates down dip, with a peak at 180 m below surface (750 N). It appears that the mafic metavolcanic rocks are slight more conductive than the ultramafic metavolcanic rocks in the northern part of the section.

The contact at 200 S, between mafic metavolcanic rocks to the south and metasedimentary rocks to the north, is clearly defined in the chargeability and resistivity, with the metasedimentary rocks more conductive and having a higher chargeability. There is a strong, discrete chargeability anomaly in the sediments at 60 S, with an underlying chargeable zone at depth. Another discrete chargeability anomaly at 360 S is located in the metavolcanic rocks and shows a slight increase in conductivity. The altered zone at 460 S shows no appreciable induced polarization anomalies.

The gravity profile is relatively smooth, with lows over the metasedimentary horizons and highs over the metavolcanic rocks. The magnetic highs indicate discrete (more iron-rich) horizons within the metavolcanic rocks. The spiky magnetic anomalies in the northern part of the section are likely due to drill casing. The strong magnetic and low gravity responses at the far north end of the profile are due to the adjacent ultramafic and mafic intrusive complex. The sharp change in the gravity response and the high conductivity zone at depth suggest that the contact dips to the south.

The overburden response is characterized by a rather thin layer of conductive material with low chargeability.

CHEMINIS

The survey lines traverse the Cadillac–Larder fault, separating a mixture of Timiskaming-type clastic metasedimentary (arenite) and chemical metasedimentary rocks (oxide facies) in the south from alkalic and subalkalic metavolcanic rocks and/or intrusions (massive flows, porphyritic flows, tuff) in the north. The strike is approximately east-northeast.

The geological section covers 500 m in the centre of the profile, and shows several narrow horizons of metavolcanic and metasedimentary rocks, with a steep south dip.

Cultural effects at the mine site significantly affect the induced polarization data between 20 S and 140 N. The sharp dipolar magnetic anomaly at 780 N does not have a corresponding aeromagnetic anomaly, and may reflect a cultural feature (e.g., drill casing).

The induced polarization data show a broad zone of higher chargeability and resistivity over the southern 900 m of the section, in the metasedimentary rocks. Similar anomalies occur in the northern part of the section, although they are somewhat less intense, shallower and thinner. They are located in the alkalic metavolcanic rocks. The responses in the central fault zone are difficult to characterize due to the cultural interference.

The bumpy magnetic response in the northern part of the section indicates iron-rich and iron-poor metavolcanic horizons.

There is minimal overburden response. There are thin pockets of conductive material, with corresponding low resistivity.

UPPER CANADA

The survey lines cross Cadillac–Larder fault and splays in the centre of the area. The lithologies, from south to north, are mafic to intermediate metavolcanic rocks, a small mafic intrusion (diorite or gabbro or metagabbro), clastic metasedimentary rocks (arenite, conglomerate), alkalic and subalkalic metavolcanic rocks and/or intrusions (massive flows, tuff), the last 2 horizons repeated and then a porphyry suite (porphyry, quartz and/or feldspar porphyry). The rocks strike east (north) to east-southeast (south).

Much of the profile is covered by the 2 geological sections. In the south, the section covers the Larder Lake deformation zone, with ultramafic metavolcanic rocks to the south and alkalic metavolcanic rocks (trachyte) to the north. In the north, the section includes a range of trachyte horizons, as well as iron formation hosted in a deformation corridor.

There are power lines at 50 S and 510 S. They have affected the induced polarization response somewhat, but not significantly.

The resistivity data show the contact at 1060 S between the more conductive ultramafic metavolcanic rocks to the south and the resistive alkalic metavolcanic rocks (trachyte) to the north. The conductivity anomaly centred at 0, and showing a north dip, correlates directly with the Broch Zone, bounded to the south by the B Zone Mud fault. It coincides with a chargeability anomaly in the top 100 m. There are several other chargeability anomalies along the section in the top 150 m. They generally correlate with trachyte in the north and ultramafic rocks in the south, except for one over the deformation corridor at 300 S. The Larder Lake deformation zone shows a sharp chargeability low near surface.

Some of the trachyte horizons produce discrete, high amplitude magnetic anomalies. One gravity high correlates with the ultramafic rocks immediately south of the Larder Lake deformation zone. Another gravity high is centred on the deformation corridor at 300 S, with a coincident magnetic anomaly, both resulting from the iron formation.

The overburden resistivity response suggests that it thickens in the southern part of the section. In places, it is difficult to separate the overburden response from underlying bedrock.

KIRKLAND LAKE GOLD

The section presented on the back-pocket chart consists of portions of 2 survey lines: line 0+00 from the south end to 600 S, and line 1+00W north of 600 S.

The survey lines cross Cadillac–Larder fault and splays in the centre of the area. The lithologies, from south to north, are an alkalic intrusive suite (syenite, monzonite, granite, diorite, syenodiorite, monzogabbro, hornblendite), a mixture of alkalic and subalkalic metavolcanic rocks and/or intrusions (massive flows) and Timiskaming-type clastic metasedimentary rocks (conglomerate), again the conglomerate on its own, and then the reverse of the previous sequence. The rocks strike east-northeast.

The geological section covers the northern two-thirds of the profiles. It shows several horizons, mainly composed of conglomerate, tuff or syenite. It also shows the Main Break (Cadillac–Larder fault) and 2 splays (Main Break splay and South Break). The rocks dip steeply to the south.

There are power lines at 1440 S that do affect the induced polarization responses somewhat.

On line 0+00, there are 4 main zones:

- 2700 S to 2200 S – moderate chargeability at depth; moderate conductivity; somewhat active magnetic response of lower amplitude; correlates with the alkalic intrusive suite
- 2200 S to 1700 S – low chargeability (weak high at 1940 S); high resistivity; active magnetic response; correlates with southern part of mixed unit (alkalic metavolcanic and clastic metasedimentary rocks)
- 1700 S to 1200 S – power lines complicate the anomalies; high chargeability (with some shallow lows); high conductivity to the south; strong magnetic anomalies to north; correlates with northern part of mixed unit (alkalic metavolcanic and clastic metasedimentary rocks)
- 1200 S to 600 S – low chargeability (weak high at 900 S), high resistivity, flat magnetic response (which extends to 450S), correlates with the tuff that forms the hanging wall of the South Break.

On line 1+00W, there is one chargeability high (140 N) centred on the Main Break and a nearby splay of the Cadillac–Larder fault, with a strong magnetic anomaly over the Main Break, all hosted in syenite. There is a second chargeability high (750 N) over a tuff horizon, which is active magnetically. The displayed section of this line is generally resistive.

The gravity field is quite flat on line 0+00, but shows a steadily increasing gradient to the north on line 1+00W. This is due to the mafic intrusive and/or large pile of mafic metavolcanic rocks north of the profile.

The overburden is thin, characterized by pockets of conductive material with low chargeability.

MATACHEWAN

The southern half of the survey lines are located in Huronian Supergroup metasedimentary rocks (Gowganda Formation). To the north, the lines traverse mafic to intermediate metavolcanic rocks (massive flows) in fault contact with Timiskaming-type clastic metasedimentary rocks (conglomerate). The strike is approximately east.

There is a foundation at 330 N that may have some effect on the Insight data. The power lines at 560 N do not appear to have interfered with the measured data.

There is a south-dipping chargeability anomaly, whose top edge is located near surface at 750 N and extends to a depth of 200 m, which correlates quite well with the upper edge of the drilled-off mineralized and/or altered zone, although the latter shows a steeper dip. The chargeability anomaly extends vertically deeper, where it coincides with the deeper mineralized and/or altered zone at 550 N. Below 400 m, there is a broad zone of high chargeability between 420 N and 860 N. This may represent the roots of the mineralized system noted above. These chargeability anomalies occur in areas of high resistivity, although it decreases below 400 m. The area between 530 N and 1100 N is quite active magnetically, over the metavolcanic rocks. It drops off completely over the metasedimentary rocks to the north.

The broad gravity high centred at 400 N reflects the unit sandwiched between the metavolcanic rocks on either side, which both result in gravity lows. The metasedimentary rocks to the north produce a weak gravity high.

There is a strong, narrow chargeability anomaly at 340 N that extends to depth from 80 m below surface. It is on the southern edge of the high resistivity zone. Although it is located where a foundation is noted at surface, the chargeability anomaly coincides with a mapped, near vertical fault, as well as a magnetic spike.

There is a zone of high conductivity between 0 and 300 N, which extends further south below 350 m depth. It is likely due to the metavolcanic unit, although the anomaly does not have the uniform geometry shown in the geological section.

The Huronian Supergroup metasedimentary rocks show a flat magnetic response, low gravity response, little chargeability, and generally high resistivity. There is a vertical conductive horizon at 900 S, and a bit of magnetic activity, which may indicate a fault.

The overburden is conductive, and relatively thick across the centre of the section.

Summary and Conclusions

The project has been successful in the collection and dissemination of high-quality ground geophysical data over a variety of deposit types, lithologic and structural settings in the Abitibi region. The data, together with the regional geophysical data previously published, can be used to determine the best geophysical methods to explore for analogues to the deposits on these properties.

GENERAL CONCLUSIONS

1. Each property typically hosts several lithologies over a short distance, resulting in a range of geophysical responses. An integrated approach to interpretation allows for accurate discrimination of these units in the vertical as well as horizontal.
2. Inversion of the Insight and pole–dipole data provide sections that are much easier to correlate with known geology, and a better depiction of unknown geology for interpretation. They are much more intuitive from a geological perspective than a pseudo-section.
3. The surveys provide a footprint for a variety of cultural features encountered in a built-up area such as the Abitibi (e.g., mine sites, power lines, pipelines, drill casing). They demonstrated that these geophysical surveys are viable in areas of cultural interference, which the effects restricted to section widths of 200 m or less.

SUCCESSES

1. Many of the ground surveys show anomalies that exist where, according to the geological section, little or no drilling has occurred. This applies particularly to the chargeability. Thus, there are new targets that have been generated by the surveys.
2. The induced polarization surveys have clearly demonstrated that the Insight system provides coherent geological information well beyond the depth capabilities of a conventional pole–dipole array, and is not critically affected by the conductive overburden conditions typically found in the Abitibi area.
3. The induced polarization data proved useful at mapping lithology and anomalous fault zones. The Insight data provided information on geometry of the units at depth.

FUTURE OF GROUND GEOPHYSICAL SURVEYS IN THE ABITIBI AREA

1. It is apparent from this project that magnetic, gravity and some type of induced polarization survey provides high resolution, complementary data that, when interpreted, provide critical information on lithology and structure, as well as drill targets, throughout the Abitibi area.
2. The regional geophysical data (airborne magnetic and electromagnetic, gravity) should be consulted as part of the planning process for any ground survey, to determine which method(s) are most suitable for mapping and targeting.
3. The depth penetration and resolution requirements must be considered in the choice of induced polarization system and array. There is cost–benefit trade-off when comparing a conventional array (e.g., pole–dipole, dipole–dipole) that provides high spatial resolution at shallow depths (e.g., top 100 m), to a more comprehensive solution (e.g., Insight system) that provides greater depth penetration (several hundred metres) and superior noise rejection, but at a cost premium.
4. Ground electromagnetic surveys and down-hole surveys (e.g., electromagnetic, induced polarization, magnetic, physical property) were not incorporated in this study, but they certainly must be considered as part of any program.

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Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 90**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

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